A Streamlined Pipeline Utility for Analyzing Universal DTI Data in MIPAV

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Introduction

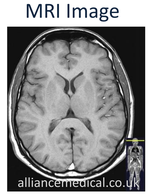
Diffusion Tensor Imaging

Diffusion Tensor Imaging (DTI) is a MRI imaging modality that indirectly images fibrous white matter brain tissue (nerve axons) by detecting water diffusion that tends to occur anisotropically along nerve fibers.

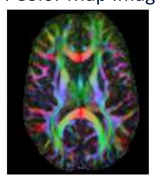
DTI is non-invasive, measures water diffusion along any oblique angle, reveals detailed anatomy of white matter through fiber orientations , and improves understanding of connectivity.

Scientists are currently applying DTI to study a wide variety of fields including traumatic brain injury, brain tumors, Alzheimer's disease, and multiple sclerosis.

MRI Image



DTI Color Map Image



MIPAV- Medical Image Processing, Analysis, and Visualization

- Comprehensive, extensible, and platform-independent JAVA based medical image processing and visualization software application
- Enables quantitative analysis and visualization of medical images from numerous modalities (i.e. PET, MRI, CT, and microscopy)
- Provides the foundation and tools needed to assist NIH researchers with the processing of hypothesis-driven imaging research data
- Freely available via the MIPAV website (http://mipav.cit.nih.gov).

Objective

We created a prototyped MIPAV DTI pipeline including DTI pre-processing, tensor calculation, fiber tracking, and visualization steps.

The goal of the MIPAV DTI pipeline was to implement a sophisticated, user-friendly DTI pipeline that has universal processing for all Diffusion Weighted Imaging (DWI) datasets acquired from any MRI scanner (i.e., Philips, Siemens, and GE).

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Workflow Results

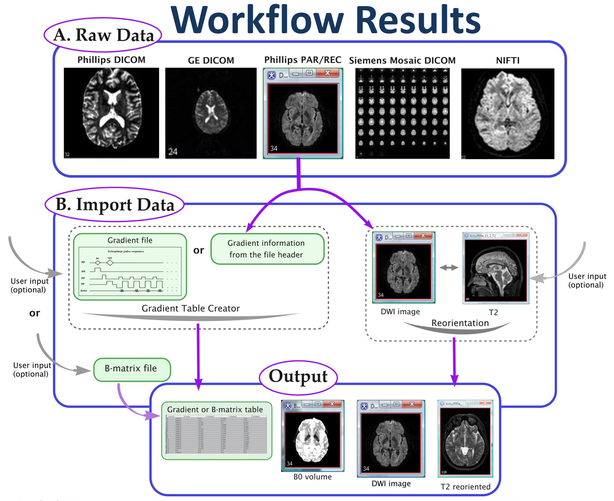


Figure 1. (A) Raw data DWI are acquired from many different MRI scanners (i.e., Siemens, Philips, and GE) in various file formats (i.e., DICOM, NIFTI, and PARREC). (B) During the import data step, the user uploads DWI and T2. Panel reads gradient or bmatrix information from header or user loaded file which is displayed on table.

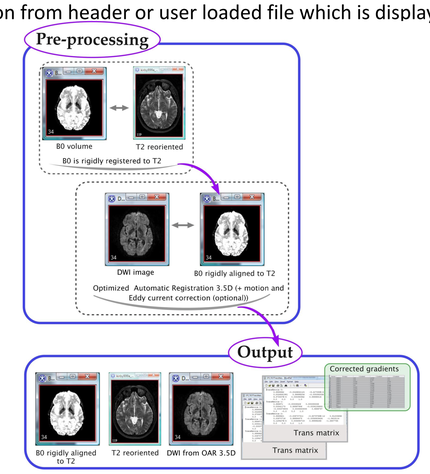


Figure 2. The pre-processing step extracts the B0 which is rigidly registered to T2. DWI is registered to rigidly aligned B0 to perform motion correction and eddy current distortion correction.

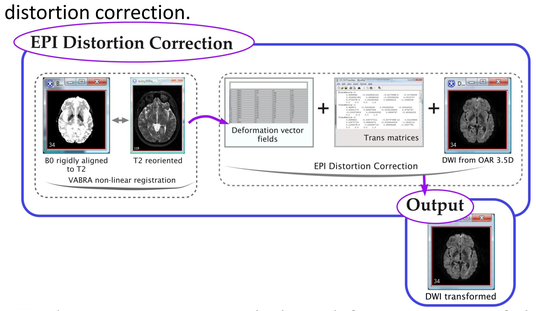


Figure 3. EPI distortion correction calculates deformation vector fields using VABRA registration from rigidly aligned B0 to T2. It uses trans matrices outputs from pre-processing and the VABRA deformation vector fields to create corrected DWI.

Workflow Results (cont.)

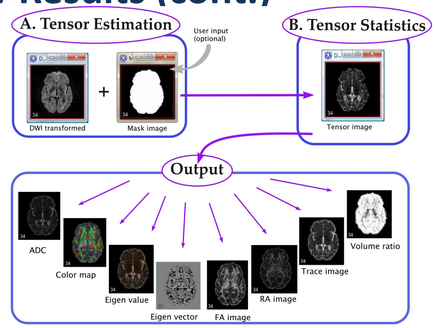


Figure 4. (A) Tensor estimation creates tensor from post-processed DWI ,bvalue/gradient information or bmatrix values, and mask image. (B) Tensor statistics uses tensor image output to create ADC, Color Map, Eigen Value, Eigen Vector, FA, RA, Trace, and Volume Ratio images.

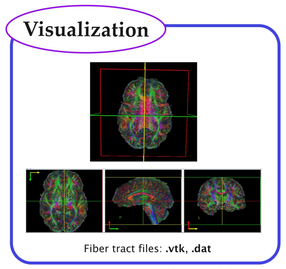
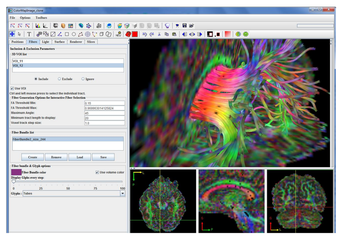
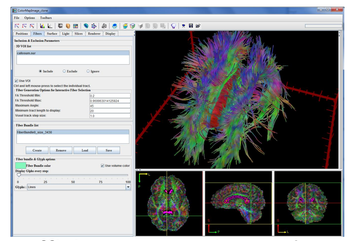


Figure 5. The visualization panel loads tensor, Color Map, Eigen Vector, Eigen Value, and FA image outputs to create 3D visualizations of fiber bundle tracts in the white matter of the brain. User can save fiber tracts in .vtk and .dat file formats.

Conclusion Model





The MIPAV DTI pipeline facilitates the efficient processing and analysis of high volumes of DWI data in one application.

The final step of the pipeline, the visualization panel, allows users to specify Volumes of Interests (VOIs) to display fibers tracts going through a specific VOI.

- -Users can also seed individual fiber tracts based on mouse clicks
- -Local diffusivity of the white matter is represented by glyphs including ellipses cylinders, lines, tubes, and arrows

References

McRobbie DW, Moore EA, Graves MJ, MR Prince (2003) MRI. From picture to proton. Cambridge, UK: Cambridge University Press

Mori, Susumu (2007) Introduction to Diffusion Tensor Imaging. Amsterdam, The Netherlands: Elsevier

Acknowledgments

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